Effects of crop rotation, herbicide application and nitrogen on the emergence of *Vicia spp.*

Einfluss von Fruchtfolge, Herbiziden und Stickstoffdüngung auf den Auflauf von Vicia spp.

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DOI 10.5073/jka.2018.458.066

Abstract

A long term field trial regarding crop rotations, application of fertilizer and pesticides was established in 1998 at the Julius Kühn-Institute experimental field in Dahnsdorf. The experimental field is located in the state of Brandenburg (Germany) about 50 km from Berlin. The long-term field trial consists of two crop rotations: (A) peas – winter barley – winter rye – white clover (for some years fallow) - winter barley – winter rye and (B) continuous cropping of winter rye. In both crop rotations the experimental treatments are: 1) no fertilizers - no pesticides, 2) no fertilizers - pesticides, 3) fertilizers - no pesticides and 4) fertilizers – pesticides. Weeds are counted in autumn or spring; in the treatments with herbicide application also before herbicide application. Both weed species and number are determined. The influence of the crop rotation regarding the weed infestation was strongest for treatment 1) and declined with fertilizer and pesticide use. The crop rotation (A) generally showed lower *Vicia spp.* infestation, while the continuous cropping of winter rye (B) promoted *Vicia* spp.. The infestation was very different throughout the years. The numbers per m^2 ranged from 0 up to 144.8 in treatment (B) (continuous cropping of winter rye) with no fertilizers and no pesticides (1).

Keywords: Fertilization, long-term field trial, plant protection, vetches

Zusammenfassung

In einem Langzeitversuch des Julius Kühn-Instituts wird seit 1998 der Einfluss von Fruchtfolge, Düngung und Pflanzenschutz auf dem Versuchsfeld Dahnsdorf untersucht. Dahnsdorf befindet sich in Brandenburg, rund 50 km von Berlin entfernt. Dieser Dauerfeldversuch besteht aus 2 Fruchtfolgen (A): Erbse – Wintergerste – Winterroggen - Weißklee (einige Jahre Brache) – Wintergerste – Winterroggen und (B) Winterroggen im Daueranbau. In beiden Fruchtfolgen werden die folgenden Varianten getestet: 1) kein Pflanzenschutz – keine Düngung, 2) keine Düngung – Pflanzenschutz, 3) Düngung – kein Pflanzenschutz und 4) Düngung und Pflanzenschutz. Der Unkrautauflauf wird im Herbst oder Frühjahr vor der Herbizidbehandlung nach Art und Anzahl gezählt. Der Einfluss der Fruchtfolge auf den Unkrautauflauf ist am stärksten für Variante 1) und nimmt beim Einsatz von Düngungen und Pflanzenschutz ab. Die Fruchtfolge (A) hat generell einen geringeren Besatz mit *Vicia spp.*, die Fruchtfolge (B) fördert hingegen *Vicia spp.*. Die Anzahl der aufgelaufenen *Vicia spp.* Pflanzen war über die Jahre hinweg sehr unterschiedlich. Die Anzahl reichte von 0 bis 144,8 Pflanzen/ m^2 in der Fruchtfolge (B) und der Variante 1).

Stichwörter: Dauerfeldversuch, Düngung, Pflanzenschutz, Wicken

Introduction

The reliable estimation of long-lasting effects of crop rotation, fertilization and plant protection and their combined effects is only possible with long-term field trials. The public is concerned about the use of pesticides and even fertilizers. For that reason a realistic view with the background of scientific results is needed. Especially for the development of weeds long-term field trials are necessary (SCHWARZ and PALLUTT, 2016).

Crop rotation has an enormous effect on the weed development (BÖHM, 2012). But also the combination of different factors like fertilization and pesticides is relevant for the emergence of weeds (SCHWARZ and PALLUTT, 2010).

Vicia hirsuta is mainly a problematic weed for organic farming (EISELE, 1996; LUKASHYK et al., 2004).

Materials and Methods

The experimental fields of the Julius Kühn Institute are located in Dahnsdorf. The experimental site is situated in southern Brandenburg (52.108494 N, 12.636338 E), so called "Hoher Fläming", near the town of Bad Belzig. The average annual temperature and mean annual precipitation (weather station on the field) is 9.4 °C and 597 mm (1997 – 2016); with prolonged dry periods in early summer. The soil is a loamy sand soil with 57.9% sand, 37.5% silt and 4.6% clay; the pH is 5.8.

This long-term field trial consists of two crop rotations:

1. (A) peas – winter barley – winter rye – white clover (for some years fallow) - winter barley – winter rye and
2. (B) continuous cropping of winter rye.

In both crop rotations the experimental treatments are:

3. 1) no fertilizers - no pesticides,
4. 2) no fertilizers - pesticides (herbicides, fungicides and insecticides),
5. 3) fertilizers - no pesticides and
6. 4) fertilizers – pesticides (herbicides, fungicides, insecticides and growth regulators).

Both weed species and number were recorded for each plot. For treatment 2) und 4) the weed counting was done before herbicide application.

All plots were ploughed and sowing dates were chosen as common for the region. Plant protection was done with the integrated approach. The monitoring results were taken into account for the decision making. Thresholds were important components for the decision making. The pesticides were chosen according to a sufficient control of the regarding pest. The application rates of the pesticides were based on the necessary level.

The weed emergence in winter rye for the crop rotations (A) and (B) was compared for the 4 experimental treatments in each year.

Results and Discussion

Comparing the weed emergence expressed as number of dicotyledonous weeds for the years, the results show that the number of weeds differs between the crop rotations and the experimental treatments. Table 1 lists the results for the mean of the years from 1999 till 2017. For the treatments without pesticides (1 and 3) not surprisingly the number of dicotyledonous weeds is larger than for the treatments with pesticides (2 and 4). For the main monocotyledonous weed *Apera spica-venti* the values are different (results not shown). The continuous cropping of rye (B) shows lower emergence of dicotyledonous weeds for the treatments 2 and 4 compared to the crop rotation (A).

Tab. 1 Mean of dicotyledonous weeds/m^2 (1999 – 2017) for each crop rotation and experimental treatment.

Tab. 1 *Mittelwert der dikotylen Unkräuter pro m^2 (1999 – 2017) für jede Fruchtfolge und Variante.*

	Experimental treatment			
Crop rotation	**1**	**2**	**3**	**4**
A	347	117	261	94
B	306	45	237	16

A closer look at the different species of the dicotyledonous weeds shows that among others *Centaurea cyanus, Matricaria spp., Viola arvensis* and *Stellaria media* are relevant.

Observing the occurrences of *Vicia spp.*, there is a clear focus on the treatments without herbicides and also without fertilization (1). *Vicia spp.* is a legume, in Dahnsdorf mainly the species *Vicia hirsuta* emerged. The weed is typical for low competitive crop populations (Rydberg and Milberg, 2000).

Figure 1 illustrates the emergence of *Vicia spp.* for treatment 1 (without fertilizer and pesticides) in both crop rotations.

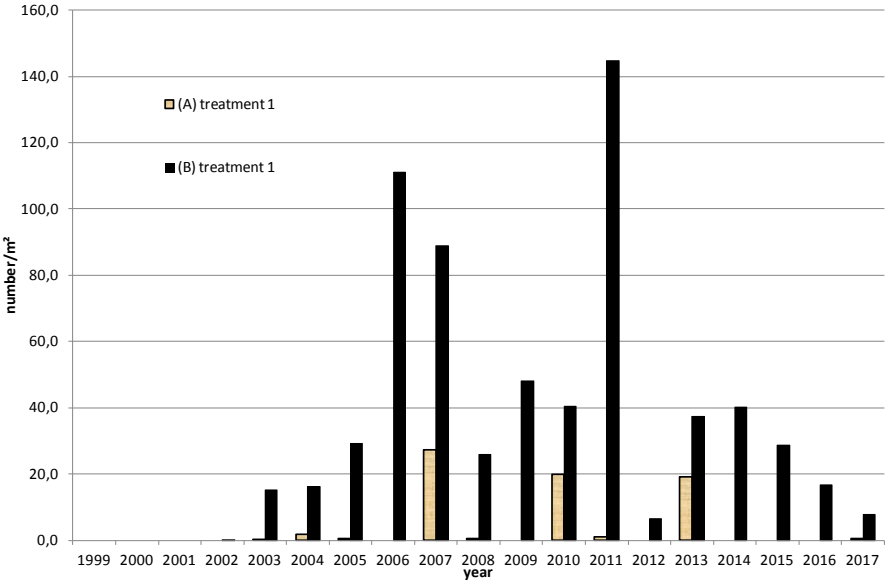

Fig. 1 Development of the emergence of *Vicia spp.* for both crop rotations (A), (B) with treatment 1.

Abb. 1 *Entwicklung des Auflaufs von Vicia spp. in den beiden Fruchtfolgen(A), (B) in der Variante 1.*

As seen in Figure 1, the development of *Vicia spp.* needs some years. For the continuous cropping of rye (B) the numbers have been rising since 2003, but with an interesting development. It seems that after high numbers of *Vicia spp.* in the years 2006, 2007 and 2011, the number decreased in the following years. This could have different reasons, like the conditions in autumn, but one hypothesis is that the legume *Vicia spp.* assimilates some air nitrogen and so other more competitive weeds take benefit of the available nitrogen. LUKASHYK et al. (2004) gave similar statements for *Vicia hirsuta*. The crop rotation (A) shows for each year lower numbers of *Vicia spp.* compared to crop rotation (B).One reason could be, that the continuous cropping of winter rye promotes *Vicia* spp.. Similar results were obtained in Organic farming (EISELE, 1996).

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